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FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT
CD NO.

50X1-HUM

COUNTRY USSR

SUBJECT Scientific - Electricity, electric-spark machining

DATE OF INFORMATION 1950

DATE DIST. 28 Aug 1951

HOW PUBLISHED Monthly periodical

WHERE PUBLISHED Moscow

NO. OF PAGES 2

DATE PUBLISHED Apr 1950

SUPPLEMENT TO REPORT NO.

LANGUAGE Russian

THIS IS UNEVALUATED INFORMATION

SOURCE Elektrichestvo, No 4, 1950, p 73.

THE MECHANISM OF THE ELECTRIC-SPARK MACHINING OF METALS

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The following is a Russian summary of an article originally published in Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya, Vol XIII, No 5, 1949.

In some types of electric discharges, extensive destruction of one or both electrodes takes place. This harmful effect -- "electrical erosion" -- has lately came into wide use in working metals by the electric spark method [electric-spark machining] proposed by by B. R. Lazarenko. It is a very complex process and its physical mechanism is still unexplained.

From an examination of existing material on the subject, the authors consider that the phenomenon of electric erosion is most pronounced in a high-voltage condensed spark discharge and in a low-voltage arc discharge when the arc is shunted by a large capacitance (arc "under spark conditions"). By reducing the voltage to which the capacitor is charged, and correspondingly increasing its capacitance, it is possible to obtain the same current in the low-voltage arc discharge "under spark conditions" as in the high-voltage discharge.

In the spark discharge, the current density may be very high, of the order of 10^5 - 10^6 a/cm^2, while in the arc discharge it rarely exceeds 10^2 - 10^3 a/cm^2. In the spark discharge the electrode metal vaporizes as bright streams or jets which fly out normally to the surface of the electrodes with a speed of several kilometers per second. Hence, like explosive blasts, they can destroy obstacles which they encounter, primarily the opposite electrode. This, the authors consider, is the main cause of electrode erosion, i.e., the erosion is not directly connected with the electric discharge but is a secondary process brought about by the mechanical action of the vaporized metal streams produced by the discharge. It follows from this theory that discharge conditions (small current density, large distance between electrodes) might exist for which the jets would not be able to destroy the opposite electrode.

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[illegible] experiments which they have carried out with such [illegible] conditions, illustrated by good photographs. In the first series of [illegible], it was convincingly shown that the erosion is considerably [illegible] the gap between the electrodes is large than when it is small.

In the next series of experiments, it was shown that the brightness, [illegible] and configuration of the jets is greatly dependent on the shape of [illegible] of the electrodes and on the material used in their construction. The best jet is obtained using a copper electrode with a pointed end.

[illegible] theory of electrical erosion, which is based on the destructive [illegible] jet from the opposite electrode, must eliminate or consider. [illegible] the destruction when the jet is shielded. An experimental check [illegible] a mica plate shield considerably reduced the destructive action [illegible] the opposite electrode. The jet formed an indentation in the [illegible].

[illegible] from the part played by the jet, the authors devised a series of [illegible] with electrodes located in millimeter capillaries drilled into [illegible] quartz. The jet escaping through the side channel was unstable but had [illegible] destructive action when the power supplied to the electrodes was large. [illegible] jet became narrow and stable when the power was reduced, but had only [illegible] action on the metal plate at which it was aimed.

[illegible] destructive effect of the jet was intensified when the electrodes were [illegible] in a liquid. Evidently the liquid limits the passage, hindering, [illegible] secondary, the expansion of the jet and increasing its destructive [illegible] tion.

In conclusion, it is stated that the experiments confirmed the authors' [illegible] on the mechanism of erosion of metals, and on the secondary process [illegible] by the destructive action of the jets on the opposite electrode. [illegible] condition for realizing this mechanism, evidently, is that the [illegible] more rapid than a critical speed. As regards the actual destructive process, the problem is still unsolved, the possibility that phenomena akin to [illegible] play a part in destroying the metal cannot be ruled out.

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